

WACO 25 KIP TOWERS

THE PROBLEM - WITH WACO 25 KIP SHORING:

In November, 1992 during placement of concrete for stems and soffit of a box girder bridge a single 25 kip capacity WACO tower appeared on the verge of collapse and had to be augmented with a secondary tower and auxiliary posts. The compressive bracing in the long direction bowed or buckled about the time that concrete was being placed up to mid-height for the stems. The end frames of the 25 kip towers were aligned under the structure stems, while the long tower direction matched the structure stem spacing of 8'-0".

The 25 kip WACO tower units are supposed to have a safety factor of 2.5 at rated load. The end frames have a pair of horizontal structural tube struts in the upper 2 feet, and circular tube X-brace in the lower 4 feet, with all end connections welded to the structural tube legs. Studs welded to the inside upper and lower portions of the legs serve as connectors for the round tube cross bracing (also X type bracing) which is erected in the alternate direction to make up a square or rectangular tower. The cross bracing for the 25 kip towers look very similar to much lower capacity (11 kip) towers or to conventional painters scaffold bracing. In the cross bracing direction there is no horizontal top member to distribute transverse loading to compression and tension members.

Site investigation showed that the bottom of some of the towers in the long (8' -0") direction measured about 7'-11", 6 foot higher at the top of the lower tower unit the horizontal measurement was about 8'-1", and the top of the next tower unit measured less than 8'-0". These measurements were all supposed to measure very close to 8'-0", but more importantly the measurements were all supposed to be the same to insure plumb tower legs. It was noted that the top jack plates were fixed to the top cap with clamps, and that irregularities in leg alignment extended through the extension frames and into the upper jacks.

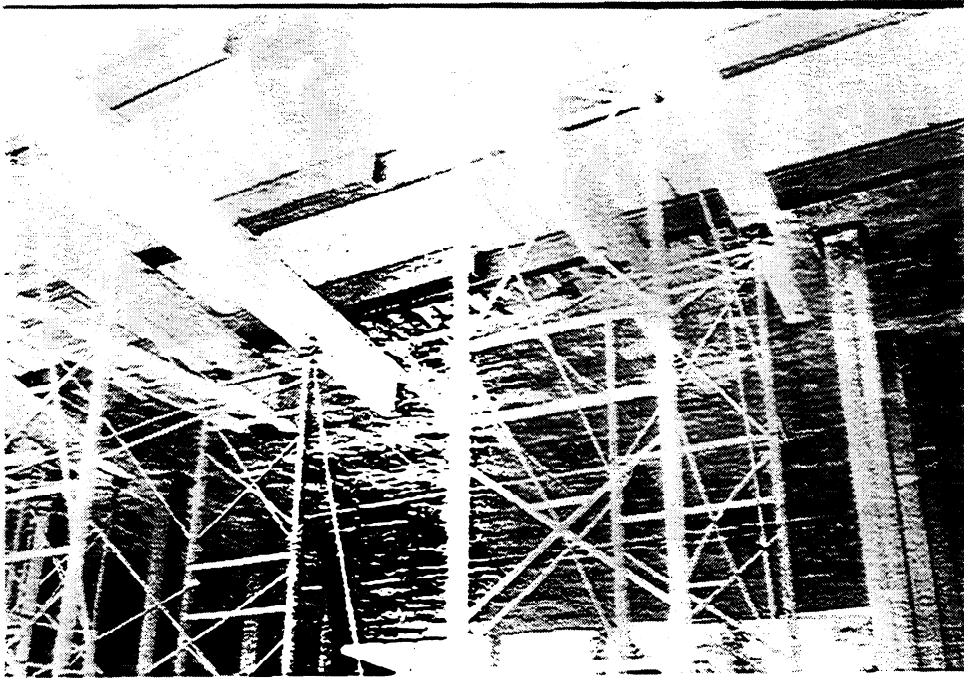
WACO 25 kip towers can normally be erected as described above because of the extremely loose tolerance at the leg to leg connections, because of loose connections at the cross brace midpoints and at the end connections, because of uneven foundations, because of bent or worn components and because of poor workmanship.

The site investigation also demonstrated that there is a large amount of looseness or tolerance in the leg to leg connections made with coupling pins, for the leg extensions, and for the jack connections. The jacks come in two configurations, either with swivel or with fixed plate connections. It was noted that fixed head jacks were used at the tops of the towers.

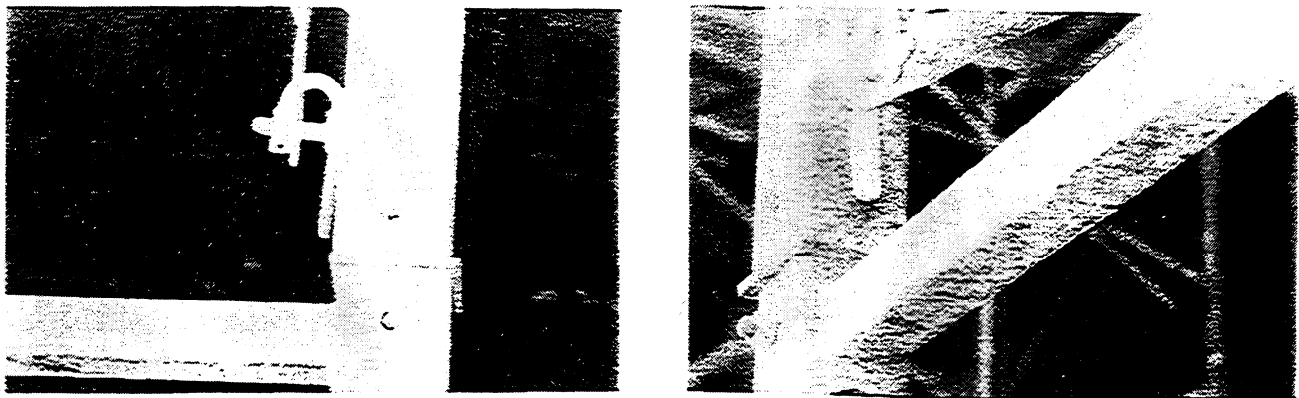
A WACO representative who visited the job site commented on the falsework in the following manner:

End frames must be plumb, and uniform spacing between end frame legs as falsework erection progresses upward must be maintained by measuring or by use of gage blocks. The leg coupling pins furnished some moment capacity which probably prevented total collapse of the distorted tower.

Copies of photographs that follow depict potential alignment problems with WACO 25 kip towers,

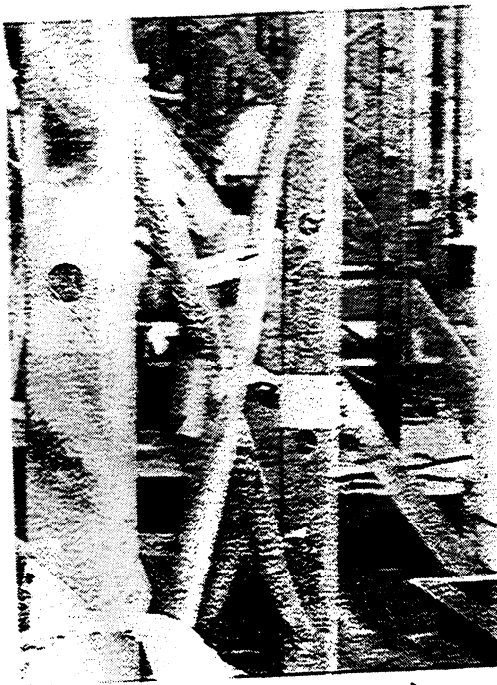
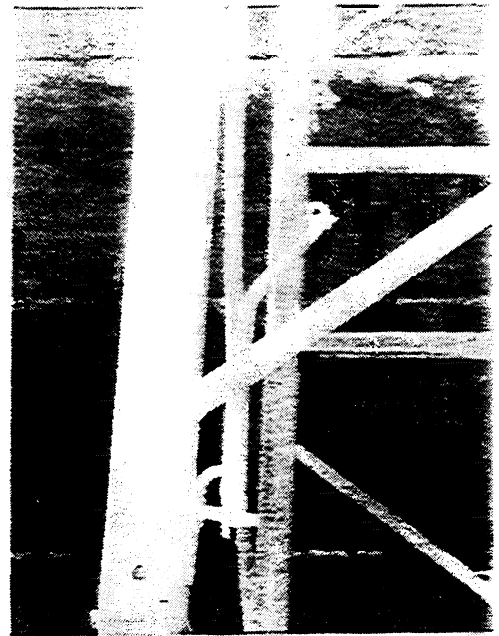


Typical tower configuration. Note bowed bracing.



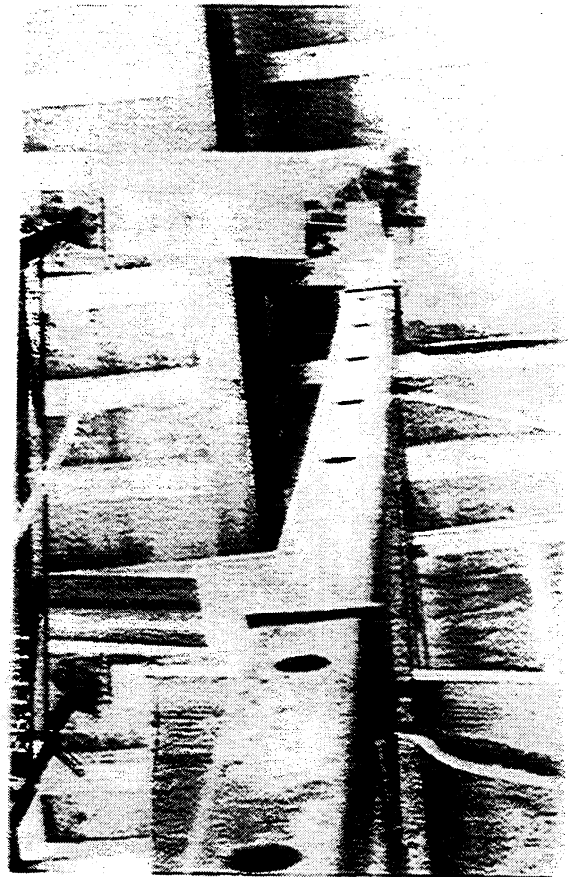
Offset tower legs

FALSEWORK MEMO NO. 14 (02/93)



Bent or bowed X and cross bracing.

FALSEWORK MEMO NO. 14 (02/93)



Tower leg misalignment

THE SOLUTION - FOR WACO 25 KIP SHORING:

WACO towers have previously been tested and approved for use at a rated capacity of 25 kips maximum per leg with a safety factor of 2.5. Testing was performed with undamaged tower units erected properly.

If proper care is exercised in erecting WACO 25 kip towers in conformance with proper guidelines, circumstances similar to those pictured previously should not occur.

Guidelines for proper erection of WACO towers are outlined in the WACO publication titled "ERECTION INFORMATION FOR SHORE 'X' TOWERS"; in Chapter 6 of the falsework manual under the heading of, "Intermediate strength shoring"; and in accordance with the instructions set forth in Chapter 9 of the falsework manual, with particular attention being given to the section titled "Steel Shoring".

When falsework plans are received which include "WACO-SHORE 'X' 25 K" vertical shoring be sure to receive all pertinent information about the tower components, including the cross bracing sizes according to the WACO numbering system. If not furnished, request from the contractor the publication titled "ERECTION INFORMATION FOR SHORE 'X' TOWERS".

When reviewing the falsework keep in mind that the tower capacity is reduced to 20 kips if swivel head jacks are to be used, that the jack extension is limited to 14 inches, that extension frames are to be braced, that leg loadings are not to have greater than 4 to 1 ratios, that additional bracing is required for tower heights greater than three frames, and that system stability must be considered. WACO 25 kip towers are not designed to resist lateral loadings, so alternate support will be required for wind and for 2% of the dead load or greater lateral loadings. When tower height is to be greater than 5 frames plus an extension a written statement that the shoring will carry the design loads will be required from the shoring manufacturer before the drawings are approved.

As soon as practical after WACO materials are received on the job review the components to ascertain that they conform to the falsework drawings and that they are undamaged.

When WACO tower falsework erection starts, become involved to confirm that the end frames and extensions are erected plumb, that cross bracing is the proper type and is in good condition, that tower legs are erected symmetrically without offsets at the connector locations, and that the entire assembly conforms to the intent of the falsework drawings and to WACO recommendations.

If there is some question as to whether components are truly WACO parts, require in writing, a statement from a WACO representative that all parts are as represented, and that the system is appropriate for the intended use.

Keep an eye on the falsework, not only when the towers are being loaded, but periodically thereafter because of possible eccentric loadings which can develop due to differential settlement between tower legs or between adjacent towers. Those legs which settle the least will be picking up additional load from the tower legs which settle more.

Attached are three sheets from WACO literature. The first two sheets (numbered -3- and -4-) describe tower parts and the last sheet lists some of the Steel Frame Shoring Safety Rules.

SCREW ADJUSTMENTS	4" TO 28"
EXTENSION	1'- 0" TO 5'-0"
1 TIER	25,000 lbs./leg
2 TIERS	
3 TIERS	
4 TIERS	
5 TIERS	
6 TIERS	CONSULT WACO ENGINEERING

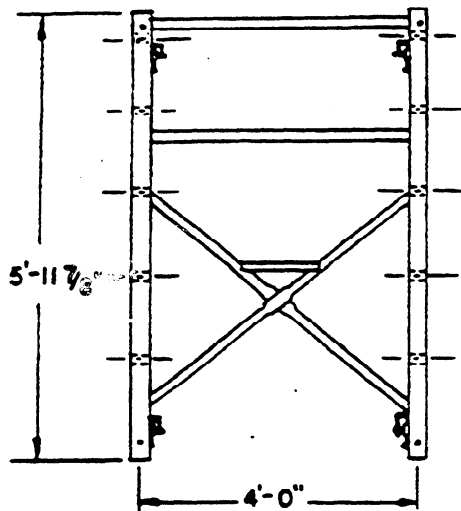
2.5:1 safety factor (average)

ALLOWABLE WORKING LOADS

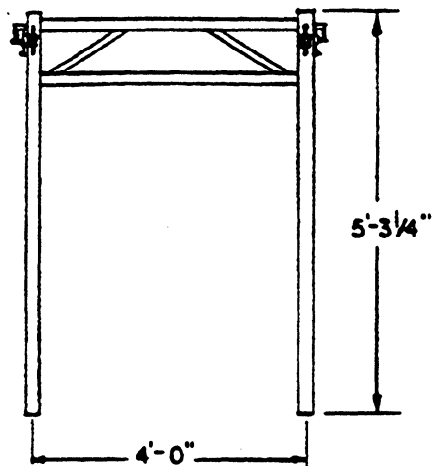
GENERAL REQUIREMENTS

- 1.) For towers over 37'-4" high consult with Waco Engineering Department.
- 2.) Extensions: 1) 1'-0" to 2'-0" require side crossbraces only.
2) 3'-0", 4'-0" and 5'-0" require side crossbraces and end cross braces on the face of the extension frame.
- 3.) Cross Braces: 1) For frame spacing of 2'-7-3/4" to 7'-0", Series #0244-XX, 20XX-00, 21XX-00, or 25XX-00 may be used.
2) For frame spacing over 7'-0" to 10'-0" inclusive, Series 25XX-00 braces must be used.
3) When 12'-0", 13'-0" or 15'-0" crossbraces are used in a tower, consult with the Waco Engineering Department.
- 4.) Adjustments: Screw adjustment is the sum total of the top and bottom screw adjustment.
- 5.) Bracing: For Stability during erection, 2" X 6" minimum bracing with #2570-02 nailing plates located at every third (3rd) frame up the tower, is recommended for towers over 3 frames high. Additional lateral bracing may be required due to wind, etc., and should be considered on a job to job basis.

FALSEWORK MEMO NO. 14 (02/93)



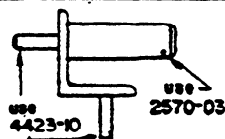
6' BASE FRAME
2525-00



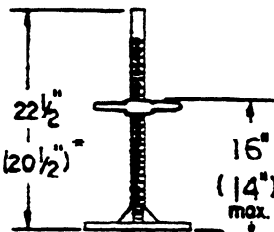
5' EXTENSION FRAME
2526-00



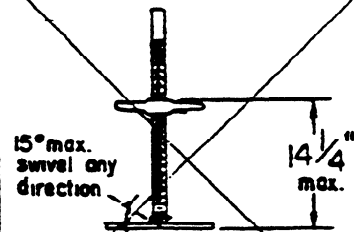
COUPLING PIN
2532-01



ADAPTER PIN
2533-00



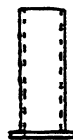
FIXED SCREW
2535-01
(2535-00)*



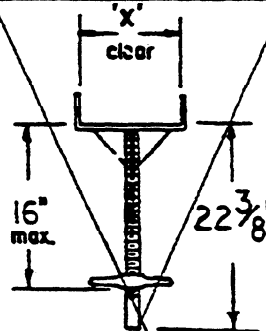
SWIVEL SCREW
2536-00



BASE PLATE
2537-00

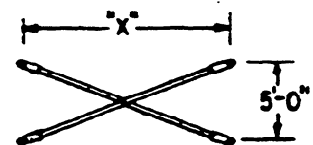


SCREW INSERT
2534-01



"X"	ASSY NO.
6 1/2"	2535-66
7"	2535-67
8"	2535-88

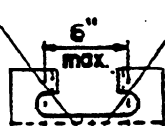
U-HEADS WITH SCREW



CROSSBRACES



EXTENSION FRAME TOP "U" HEAD
2531-00



BEAM CLAMP
2547-01

"X"	25X5-00
4'	2545-00
6'	2565-00
8'	2585-00
10'	2505-00

SEE ALSO PAGE 3

SHORE "X" 25,000#/LEG

STEEL FRAME SHORING SAFETY RULES

As Recommended by

SCAFFOLDING AND SHORING INSTITUTE

(See Separate Scaffolding Safety Rules and Recommended Steel Frame Shoring Erection Procedure)

Following are some common sense rules designed to promote safety in the use of steel frame shoring equipment. These rules are illustrative and suggestive only, and are intended to deal only with some of the many practices and conditions encountered in the use of steel frame shoring. The rules do not purport to be all-inclusive or to supplant or replace other additional safety and precautionary measures to cover usual or unusual conditions. They are not intended to conflict with, or supersede, any state, local, or federal statute or regulation; reference to such specific provisions should be made by the user. (See Rule II.)

- I. **POST THESE SHORING SAFETY RULES** in a conspicuous place and be sure that all persons who erect, dismantle or use, shoring frames are aware of them.
- II. **FOLLOW ALL STATE, LOCAL AND FEDERAL CODES, ORDINANCES and REGULATIONS** pertaining to shoring.
- III. **INSPECT ALL EQUIPMENT BEFORE USING.** Never use any equipment that is damaged.
- IV. **A SHORING LAYOUT**—Shall be available on the jobsite at all times.
- V. **INSPECT ERECTED SHORING AND FORMING:**
 - a. Immediately prior to pour - b. During pour - c. After pour until concrete is set.
- VI. **CONSULT YOUR SHORING EQUIPMENT SUPPLIER WHEN IN DOUBT.** Shoring is his business, NEVER TAKE CHANCES.

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| <p>A. USE MANUFACTURER'S RECOMMENDED SAFE WORKING LOADS CONSISTENT WITH the type of SHORING FRAME and the height from supporting sill to formwork.</p> <p>B. DO NOT EXCEED THE SHORE FRAME SPACINGS OR TOWER HEIGHTS as shown on the shoring layout.</p> <p>C. SHORING LOAD SHOULD BE CARRIED ON LEGS. Consult your shoring supplier for SHORING FRAMES that are designed for taking loads on top horizontal.</p> <p>D. IF MOTORIZED CONCRETE EQUIPMENT is to be used, be sure that the shoring layout has been designed for use with this equipment and such fact is noted on the layout.</p> <p>E. PROVIDE AND MAINTAIN A SOLID FOOTING to distribute maximum loads properly.</p> <p>F. USE ADJUSTMENT SCREWS to adjust to uneven grade conditions.</p> <p>G. USE ADJUSTMENT SCREWS to level-off, to accurately position the falsework and for easy stripping.</p> <p>H. KEEP SCREW EXTENSIONS to a minimum for maximum load carrying capacity (follow manufacturer's recommendation on screw extension).</p> <p>I. MAKE CERTAIN THAT ALL ADJUSTMENT SCREWS are firmly in contact with sills, formwork and frame legs.</p> | <p>J. PLUMB AND LEVEL ALL SHORING FRAMES as the erection proceeds. DO NOT force braces on frames to fit—level the shoring towers until proper fit can be made easily. CHECK PLUMB AND LEVEL OF SHORING TOWERS just prior to pour.</p> <p>K. FASTEN ALL BRACES SECURELY.</p> <p>L. TIE HIGH TOWERS OF SHORING FRAMES TOGETHER with sufficient braces to make a rigid, solid unit (see manufacturer's recommendations).</p> <p>M. EXERCISE CAUTION in erecting or dismantling free standing shoring towers to prevent tipping.</p> <p>N. DO NOT CLIMB CROSS BRACES.</p> <p>O. AVOID ECCENTRIC LOADS ON U-HEADS, top plates and similar members by centering stringers on those members.</p> <p>P. USE SPECIAL PRECAUTIONS when shoring from or to sloped surfaces.</p> <p>Q. USE LUMBER STRESSES as shown on layout and consistent with age, type and condition of the available lumber to be used. Use only lumber that is in good condition.</p> <p>R. RESHORING PROCEDURE SHOULD BE APPROVED BY A QUALIFIED ENGINEER.</p> <p>S. DO NOT REMOVE BRACES OR BACK-OFF ON ADJUSTMENT SCREWS until proper authority is given.</p> |
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